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Article

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Some Methodological Considerations for the relationship between Environmental Degradation, Economic Growth and Energy Consumption for South Asian Countries

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ABSTRACT

The present study is designed to investigate that how Economic Growth (EG) of the South Asian region has affected the Environmental Degradation (ED) from 1980 to 2018. This study has used Newey and West (1987) robust standard errors approach to overcome the problem of autocorrelation and heteroskedasticity in panel data. The results of the statistical model confirmed the existence of the Inverted U-shaped Environmental Kuznets Curve (EKC). Furthermore, the results also confirmed that the use of energy is also deteriorating the environment significantly. One significant contribution of the study is to check the causality between EG and CO_2 by applying a relatively new approach namely Granger non-causality test presented by Dumitrescu and Hurlin (2021). The results confirmed that economic growth is contributing towards more CO_2 emissions. The study concluded that South Asian countries should use environment-friendly renewable energy sources to achieve a higher growth rate.

Keywords: Economic Growth, CO_2 Emission, Energy Consumption, Environmental Degradation, Newey and West Approach, Non-causality
JEL Classifications: C22, F15, L98, Q43

1. INTRODUCTION

The alarming situation of Environmental Degradation (ED) after the industrial revolution of the 19th century drew the attention of international institutions like the World Bank to guide policymakers that all development policies should be integrated with environmental considerations. The World Bank's notion that there exists a trade-off between Economic Growth (EG) and ED (World Bank, 1992) paved the way for researchers to empirically check the relationship between EG and environmental quality. Several studies were conducted to check the relationship between EG and ED by using time series, cross-sectional, and panel data (Jalil and Mahmud, 2009; Joo et al., 2015; Lee and Yoo, 2016; Mehmood, 2021; Mugableh, 2015; Riti et al., 2017). After the pioneer studies of Grossman and Krueger (1995) and Holtz-Eakin and Selden (1995), a significant number of studies, based on the Environmental Kuznets Curve (EKC) hypothesis, show how EG first increase and then gradually decrease the ED (Apergis and Ozturk, 2015; Ardakani and Seyedaliakbar, 2019; Dinda, 2004; Özokcu and Özdemir, 2017; Rahman et al., 2020). In addition to the EG-ED relationship, a significant literature also investigates the role of energy consumption towards ED and studies the nexus among energy consumption, ED, and EG (Ahmad et al., 2016; Bekhet and Lojuntin, 2020; Ito, 2017; Khan et al., 2020; Munir et al., 2020; Omri, 2013; Salari et al., 2021).

The present study is designed to test the EKC hypothesis and role of energy consumption on ED by highlighting some of the common estimation errors made by previous researchers. Furthermore, this study will also check the causality among the energy consumption, ED and EG by using a relatively new technique.

Unprecedented growth in the use of energy, in the 21st century, to fuel the industry and household consumption has affected the environment adversely. Industrialization in South Asian countries, like the other Asian regions, started in the mid-late twentieth century. The introduction of the free trade concept and the idea of trade-led growth presented by Bhagwati (1988) was well bought by the world. The economies are opening up by following World Trade Organization's (WTO's) principle of integration and new sources of energy has catalyzed the production and industrial growth. This resulted in high growth rates in South Asian countries. However, this growth was at the cost of ED (commonaly measured in terms of Carbon Dioxide (CO_2) emission in Literature).

The following figures show the CO_2 emissions per capita, GDP growth and energy consumption per capita (kwh) for the South Asian countries over years.

Bangladesh, India, Pakistan and Sri Lanka become member of WTO in 1995 while Bhutan and Nepal becomes member of WTO in 1999 and 2004 respectively. Following this, the trade liberalization policies and industrialization in South Asian countries increased the CO_2 emissions (Figure 1). As shown in Figure 2, the GDP growth rate of Bhutan, Bangladesh, India, Nepal and Sri Lanka increased after joining WTO but the average GDP growth rate of Pakistan decreased due to many economicstupor. Moving on to the trend for energy consumption, Figure 3 shows that, since yar 2000, there is a continuous increase in the energy consumption per capita for the South Asian countries.

The high EG rates, use of energy by the world, and ED were well observed by the researchers in the last three decades. The researchers tried to check the nexus among these three variables by taking CO_2 emission as a proxy of ED (Acheampong, 2018; Ardakani and Seyedaliakbar, 2019; Aye and Edoja, 2017; Chontanawat, 2020; Erdoğan et al., 2019; Salari et al., 2021). The ED issue came under the limelight in the last two decades or so. The most important air pollutants include nitrogen oxide, carbon mono oxide, Sulphur dioxide, led, and particulate matter out of which the CO_2 is the worst pollutant that deteriorated the environmental quality (Houghton, 1996). CO_2 absorbs the heat emitted by the planet's surface and retains it in the atmosphere instead of letting it go to space. Although the concentration of CO_2 is just only 0.041% of the earth's atmosphere, its effects are immense on global warming. This led the researchers to link economic activities to CO_2 emissions.

The researchers have established the relationship between CO_2 emission and EG in different ways i.e. linear with positive slope (Ardakani and Seyedaliakbar, 2019; Erdoğan et al., 2019; Zaheer and Ali, 2021), Inverted U-shaped relationship (Apergis and Ozturk, 2015; Özokcu and Özdemir, 2017; Salazar-Núñez et al., 2020; Shahbaz et al., 2020), N-shapes relationship (Aljadani et al., 2021; Allard et al., 2018; Ardakani and Seyedaliakbar, 2019; Begum et al., 2015; Özokcu and Özdemir, 2017), or even no

Figure 1: CO_2 Emission per capita for South Economies

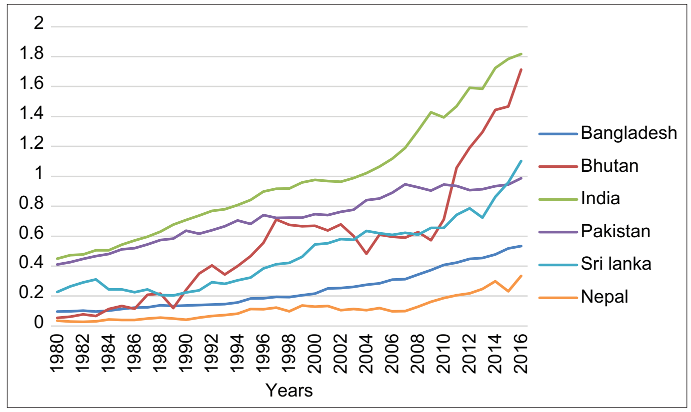


Figure 2: GDP Growth for South Economies[1]

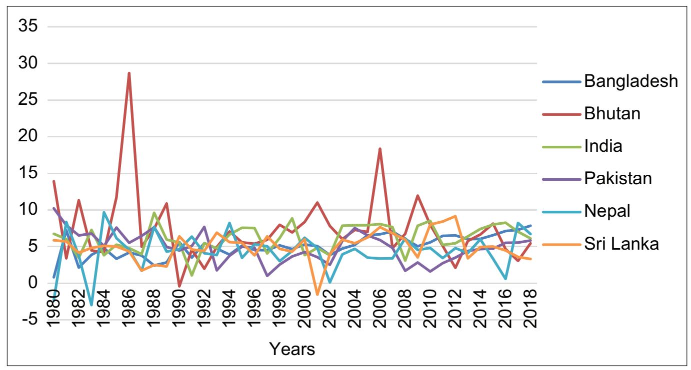
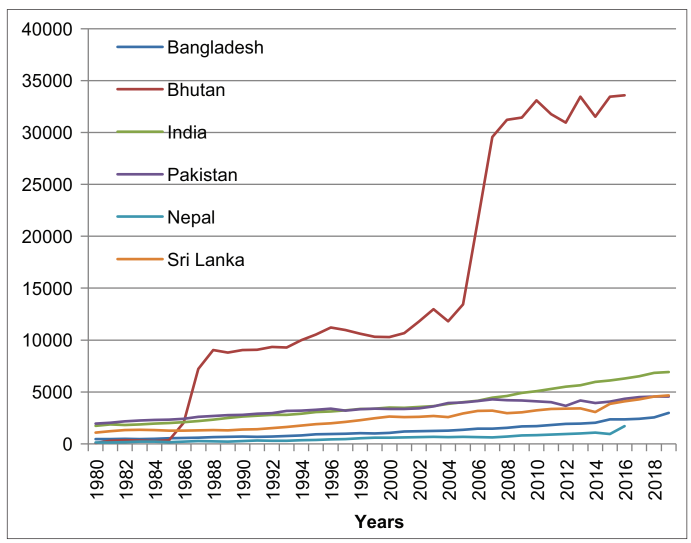


Figure 3: Energy Consumption per capita (kwh) for South Economies[2]



relationship (Aslanidis and Iranzo, 2009; Jaunky, 2011; Robalino-López et al., 2015).

In most of the studies cited above the researchers have neglected the problem of heteroscedasticity, serial correlation, and Cross-sectional Dependence (CD) which are the potential problems of a panel data (Asif et al., 2015; Azimi et al., 2020; Mohsin

1. The data used in Figure 1 and 2 is taken from World Development Indicators (WDI)
2. The data used in Figure 3 is taken from https://ourworldindata.org/energy

et al., 2021; Shaari et al., 2014). If these potential problems are neglected then the standard least square estimation may produce specious regression (Arellano, 2003; Baltagi, 2008; Drukker, 2003; Hsiao, 2007; Kao, 1999; Pesaran, 2015b; Qasim et al., 2021; Wooldridge, 2010). The present study will take into consideration the consequential issue associated with the disturbance term. This study verifies the possible problems associated with an error term and by following Newey and West (1987) estimates the robust standard errors to avoid the spurious regression.

Furthermore, many studies had tested the causal nexus between EG and CO_2 emission by using the traditional Granger causality (Ahmed et al., 2017; Al-Mulali and Che Sab, 2018; Chang, 2010; Erdoğan et al., 2020; Fodha and Zaghdoud, 2010; Gorus and Aydin, 2019; Islam et al., 2017; Lee and Yoo, 2016; Mikayilov and Hasanov, 2020; Mugableh, 2015), which may lead to methodological bias in the presence of CD (Dumitrescu and Hurlin, 2012; Wursten, 2017). In contrary to past studies, this study has applied a relatively new approach of causality presented by Dumitrescu and Hurlin (2012). This approach produces robust estimates in the presence of CD. The current paper revisits the "EKC" hypothesis by using robust standard errors and also checks the causal relationship between EG and CO_2 emission by using an updated methodology for six South Asian countries namely, Bangladesh, Bhutan, India, Nepal, Pakistan, and Sri Lanka.

2. MATERIALS AND METHODS

2.1. Data Sources

The present research aims to empirically examine the Environmental Kuznets Curve (EKC) hypothesis and causality between Environmental Degradation (ED), measured through Carbon Dioxide (CO_2) emission per capita (CO2EPC), and real GDP per capita (LRGDPPC) for the six South Asian courtiers namely Bangladesh, Bhutan, India, Nepal, Pakistan, and Sri Lanka. Afghanistan and Maldives are excluded from the present research due to the non-availability of data on the variables of interest. Moreover, the analysis for the study was conducted by using data from 1980 to 2018. Data on the variables used in the study is taken from World Development Indicator (WDI) and Penn World Table (PWT).

2.2. The Model

Previous studies tested the "EKC" hypothesis by taking LRGDPPC and LRGDPPCSQ as independent variables and LCO2EPC as a dependent variable (Abbasi et al., 2020; Apergis and Ozturk, 2015; Kasman and Duman, 2015; Shabani et al., 2021; Sharma et al., 2021). The present study has also used the same variables to develop a model with the addition of the EU as an independent variable. The model is presented below:

$$LCO2EPC_{it} = \psi_{it} + \psi_2 LRGDPPC_{it} + \psi_3 LRGDPPCSQ_{it} + \psi_4 LEU_{it} + \varepsilon_{it} \quad (1)$$

Where:

$LCO2EPC_{it}$ = is the log of CO_2 emission per capita
$LRGDPPC_{it}$ = is the log of GDP per capita, at constant prices
$LRGDPPCSQ_{it}$ = is the log of GDP per capita Square
LEU_{it} = is the log of energy use
i = indicates the number of cross-sections
t = shows the number of time periods
Ψ = is the slope coefficient
ε_{it} = is the white noise error term

2.3. Econometric Modeling

Keeping in mind the nature of the data and objectives of this research, the present study has used panel data. In conventional panel data analysis, there are three classifications of models namely the fixed effects (FEM), Random Effects (REM), and common constant model (Baltagi, 2008; Studenmund, 2014). Hausmann specification test was applied to check which of these three is suitable for the present study.

2.3.1. Hausmann specification test

Hausmann (1978) proposed a model choice test between FEM and REM. The null and alternative hypotheses are given below:

H_0: $Z'_{it}\alpha_i = 0$, REM is consistent and efficient

H_α: $Z'_{it}\alpha_i = 0$, FEM is consistent and efficient

And the test statistic is,

$$\varnothing = [b_{FE} - B_{RE}][v_{FE} - V_{RE}][b_{FE} - B_{RE}] \quad (4)$$

Where
b_{FE} = calculated parameter of FEM
B_{RE} = estimated coefficient value of REM
v_{FE} = covariance matrix of FEM
And V_{RE} = covariance matrix of REM

The results of the Specification test suggested FEM is more efficient and appropriate for the model used in the present study.

2.3.2. Fixed effect model

The general econometrics form of FEM is as follow;

$$Y_{it} = \beta_{i1} + X_{it}\beta_2 + X_{it}\beta_3 + X_{it}\beta_4 \ldots\ldots\ldots\ldots\ldots\ldots X_{itk}\beta_k + \mu_{it} \quad (2)$$

And the matrix form

$$y_{it} = \alpha_i + X_{it}\beta + \mu_{it} \quad (3)$$

Where
y_{it} = is the dependent variable
X_{it} = is the 1×K vector of independent variables
β = is the k×1 matrix of slope coefficients
α_i = captures the unobserved time-invariant effect of cross-sections

The model is referred to as the "fixed-effect model" because this model produces an independent intercept term for every individual entity. The subscript "*i*" of the slope coefficient considers that each entity may have a different intercept value but this value does not change over time *i.e.,* it is time-invariant (Baltagi, 2008; Greene, 2003; Qasim et al., 2021; Wooldridge, 2010; 2016).

2.3.3. Robustness checking

To avoid misleading results, the econometricians proposed different robustness tests to check the assumptions of Ordinary Least Square (OLS). The present study has applied an autocorrelation test for panel data proposed by Drukker (2003) and modernized by Wooldridge (2010). The null hypothesis for this test is the absence of autocorrelation. Furthermore, Modified Wald test is applied to check the problem of heteroscedasticity in the data. The null hypothesis for this test is the absence of heteroscedasticity. The results of both the tests reject their respective null hypotheses, indicating that there is a problem of autocorrelation and heteroscedasticity in the data To account for the issue of unequal variance and serially correlated disturbance, the present study has used robust standard error method proposed by Newey and West (1987).

2.3.4. Newey and west robust standard error

To cope with biased standard errors, as a result of unequal variance and serially correlated disturbance, Newey and West (1987) put forward the statistical inference to correct the standard errors. The corrected standard errors provide efficient and optimal results (Arellano, 2003; Baltagi, 2008; Hsiao, 2007; Pesaran, 2015b). The Newey and West estimator is given below:

$$Q^{\text{å}} = \frac{1}{T}\sum_{t=1}^{T} e_t^2 X_i X_t^{'} + \frac{1}{T}\sum_{l=1}^{L}\sum_{t=l+1}^{T} w_l e_t e_{t-l}\left(x_t x_{t-l}^{'} + x_{t-l} x_t^{'}\right) \qquad (5)$$

To produce robust standard errors, the first step is to calculate the maximum number of lags. Andrews (1991) and Newey and West (1987) have suggested the criteria for best lag length selection. The formula for lag selection is as follows:

$$m(T) = floor\left[4\left(\frac{T}{4}\right)^{\frac{2}{9}}\right] \qquad (6)$$

Similarly, Hoechle (2007) recommended the general principle for approximating the lag length.

$$m(T) = T^{\frac{1}{4}} \qquad (7)$$

Where
m(T) = optimal lag length
T = number of time periods

2.3.5. Dumitrescu and hurlin non-causality test

This study has applied the non-causality Granger test for the heterogeneous panel data model proposed by Dumitrescu and Hurlin (2012). The general model of panel non-causality test for two stationary variables, x and y observed for individual cross-section, i and time, T is given below:

$$y_{it} = \alpha_i + \sum_{k=1}^{K}\gamma_i^{(k)} y_{i,t-k} + \sum_{k=1}^{K}\beta_i^{(k)} x_{i,t-k} + \mu_{i,t} \qquad (8)$$

Where,

$$\beta_i = (\beta_i^{(1)},\ldots..,\beta_i^{(K)})'$$

$\gamma_i^{(k)}$ = represents the autoregressive coefficients

$\beta_i^{(k)}$ = represents the regression coefficients

The null and alternate hypotheses of homogenous non-causality (HNC) test are as follows:

H_0: $\beta_i = 0$

H_1: $\beta_i \neq 0$

The test statistic for NHC is given below:

$$W_{NT}^{NHC} = \frac{1}{2}\sum_{i=1}^{N} W_{i,T} \qquad (9)$$

Where,

$W_{i,T}$ = is the Wald statistics for cross-section for H_0: $\beta_i = 0$ and

$$Z_{NT}^{NHC} = \sqrt{\frac{N}{2K}}(W_{NT}^{NHC} - K) \rightarrow N(0,1) \qquad (10)$$

Where, Z_{NT}^{NHC} = is the standardized statistics

Similarly,

$$\hat{Z}_{NT}^{NHC} = \sqrt{\frac{N(T-2K-5)}{2K(T-K-3)}}\left(\left(\frac{T-2K-3}{(T-2K-1)}\right)W_{NT}^{NHC} - K\right) \rightarrow N(0,1) \qquad (11)$$

Where, $\hat{Z}_{NT}^{NHC}$ = is the standardized test statistic for fixed T.

2.3.5.1. Cross-sectional dependence (CD)

The non-causality panel causality test assumes that x and y are stationary. Before testing the panel unit root, the first step is to confirm the presence of CD in cross-sections. CD is defined as the correlation between spaces instead of time. This study has applied the Pesaran CD (Pesaran, 2004) and Pesaran Scaled LMS tests to check the existence of CD (Pesaran, 2015a).

2.3.5.1.1. Pesaran's CD tests

CD is the potential problem of the panel or cross-sectional data (Baum, 2011; Froot, 1989; Hoechle, 2007). The most common

Table 1: Matrix of correlations

Variables	(1)	(2)	(3)	(4)
LRGDPPC	1.000			
LRGDPPCSQ	0.999	1.000		
LEU	0.435	0.432	1.000	
LCO2EPC	0.555	0.529	0.553	1.000

Source: Author's estimation

Table 2: Regression with Newey-West standard errors dependent variable LCO2EPC

Variables	Coef.	St. Err.	t-value	p-value	[95% Conf	Interval]
LRGDPPC	14.779	2.119	6.97	0.000	10.598	18.961
LRGDPPCSQ	−0.651	0.097	−6.71	0.000	−0.842	−0.459
LEU	0.729	0.114	6.41	0.000	0.504	0.953
Constant	−88.391	11.294	−7.83	0.000	−110.681	−66.101
Mean dependent var	−1.088		SD dependent var.		0.956	
Number of obs.	180.000		F-test		132.055 (0.0000)	
Wooldridge test for autocorrelation in panel data F (1 5)	138.777 (0.0001)		Hausman specification test Chi-sq.		27.978 (0.0000)	
Modified Wald test for Group Wise heteroskedasticity in the fixed effect regression model Chi-sq. (6)	12182.56 (0.0000)		R-squared		0.860	

Source: Author's estimation. Where ***P<0.01, **P<0.05, *P<0.1

test of CD for the panel data was devised by Pesaran (2004). The Stata package of the CD test was developed by Wursten (2017) in STATA. CD test statistic is given below:

$$CD = \sqrt{\frac{2T}{N(N-1)}}\left(\sum_{i=1}^{N-1}\sum_{j=i=1}^{N}\rho_{it}\right) \tag{12}$$

H_0: No cross-sectional dependence

2.4.5.1.2. Pesaran's LMS test

The Standardized Pesaran's Lagrange Multiplier Scaled (LMS) test is also used to test the CD. The test statistic is shown below.

$$LM_s = \sqrt{\frac{1}{N(N-1)}}\left(\sum_{i=1}^{N-1}\sum_{j=i=1}^{N}T_{it}\ \hat{\rho}_{it}-1\right) \tag{13}$$

H_0: No cross-sectional dependence

2.3.5.2. Choice of unit root test

After checking the CD, the last step is to check the stationarity of the variables. The choice of unit root test depends on the absence or presence of CD in the variables. First-generation unit root tests are used if the problem of CD does not exist in the data Arellano (2003); (Im et al., 2003; Levin et al., 2002). Second generation unit root test is applied if there exists the problem of CD in the data (Im et al., 2003; Pesaran, 2007). In this study, a second-generation test namely the Cross-sectionally-augmented IPS (CIPS) test is applied due to the existence of CD. In the presence of CD, the first-generation tests are misleading.

2.3.5.2.1. CIPS test

The second-generation unit root test was developed by (Im et al., 2003; Pesaran, 2007). The general model of the CIPS test is given below:

$$CIPS = \frac{1}{2}\sum_{i=1}^{N}t_i(N,T) \tag{14}$$

H_0: Presence of a Unit Root

3. RESULTS AND DISCUSSION

Before estimating the model, the matrix of correlations among three variables of the study is obtained. The results are given in Table 1.

Table 1 analyzes the cross-correlation of the variables used in the study. All variables are positively correlated with each other. The correlation of LCO2EPC with LRGDPPC, LRGDPPCSQ and LEU is 0.999, 0.435, and 0.555 respectively.

Hausman specification test suggested that FEM is an appropriate estimator. Table 2 shows the regression results with (Newey and West, 1987) robust standard errors approach. These standard errors corrected the problems of serial correlation and heteroscedasticity in the model. To obtain unbiased results, this study has used the Wooldridge test for autocorrelation and Baum Modified Wald test for group-wise heteroscedasticity. The results suggested the presence of serial correlation and heteroscedasticity in the model as null hypotheses of both tests are rejected at a 1% level. Therefore, this study has used the Newey and West (1987) standard errors. These standard errors have produced efficient and unbiased estimates as propagated by Arellano (2003), Baltagi (2008), and Raj and Baltagi (2012).

The results presented in Table 2 confirm that at the beginning LRGDPPC is posing a negative effect and after reaching the point of inflection the effect becomes positive on the environment. The relationship of LRGDPPC and LRGDPPCSQ with Carbon Dioxide (CO_2) emission confirmed the Inverted-U shape EKC for the selected countries. It implies that initially, EG worsens the environmental quality. After reaching the turning point, it will ameliorate the environment (Grossman and Krueger, 1995). Several studies in the literature have confirmed the existence of the EKU hypothesis (Ardakani and Seyedaliakbar, 2019; Aye and Edoja, 2017; Özokcu and Özdemir, 2017; Salazar-Núñez et al., 2020; Shahbaz et al., 2020). Similarly, LEU has a direct and statistically significant effect on LCO2EPC. This suggests that increased energy use has caused Environmental Degradation (ED). These findings are similar to Bölük and Mert (2015), Chen et al., (2016), Franklin and Ruth (2012), Heidari, Katircioğlu, and Saeidpour(2015), Holtz-Eakin and Selden (1995), Mugableh (2015), Narayan and Narayan (2010), and Rahman et al. (2020).

Table 3: Cross-sectional dependence (CD) tests

Variables	Pesaran CD		Pesaran LM scale	
	Test statistic	Prob.	Test statistic	Prob.
LCO2EPC	13.194	0.000	21.523	0.000
LRGDPPC	16.295	0.000	23.781	0.000

Source: Author's estimation

Table 4: Pesaran's CIPS second generation unit root test

Variables	LCO2EPC	LRGDPPC	Critical values		
	CIPS	CIPS	1%	5%	10%
Intercept	−1.712	−1.862	−2.210	−2.330	−2.550
Intercept and trend	−2.457	−1.831	−2.730	−2.840	−3.060

Source: Author's estimation

Table 5: Dumitrescu and Hurlin (2012) Granger non-causality test results

Null hypothesis	W-Stat	Zbar-Stat	P-values
LRGDPPC does not homogeneously cause LCO2EPC	5.8161	4.6737	**0.000**
LCO2EPC does not homogeneously cause LRGDPPC	3.0700	1.3105	0.190

Source: Author's estimation

The present study has also checked the causation between LRGDPPC and LCO2EPC by using the non-causal Granger test proposed by Dumitrescu and Hurlin (2012). The first step to estimate the non-causality test is to check expected Cross-sectional Dependence (CD) in panel data.

The results of Pesaran's CD test and Pesaran's LMS test are presented in Table 3, indicate the presence of correlation between cross-sectional units at a 1% level of significance. Hence, as discussed earlier, the Pesaran Cross-sectionally-augmented (CIPS) second-generation unit root test is applied. These results are represented in Table 4 below:

The results of CIPS rejected the null hypothesis that time series are non-stationary at a 1% level suggesting that the time series LRGDPPC and LCO2EPC are stationary. Based on the results of pre-tests, the study has used Dumitrescu and Hurlin (2012) non-causal Granger test. The results are presented in Table 5.

The null hypothesis of panel causality is that the independent variable does not homogeneously cause the variable under consideration. The results of the causality test indicate the unidirectional causality running from LRGDPPC to LCO2EPC. The p-value of W-Stat and Zbar-Stat is less than 0.000 suggesting the rejection of the null hypothesis at a 1% level of significance. The results also indicate that causality running from LCO2EPC to LRGDPPC does not exist as some researchers pointed out in literature (Islam et al., 2017; Lee and Yoo, 2016; Wang et al., 2020).

4. CONCLUSION AND POLICY IMPLICATIONS

The present study is designed to empirically re-examine the Environmental Kuznets Curve (EKC) hypothesis and the causality between Economic Growth (EG) and Carbon Dioxide (CO_2) emissions for six South Asian courtiers, namely Bangladesh, Bhutan, India, Nepal, Pakistan, & Sri Lanka, using latest estimation methodologies. The fixed-effect model with Newey and West (1987) robust standard error indicates that LRGDPPC has positive and significant impact on CO_2 emission while LRGDPPCSQ has a negative and significant impact on CO_2 emission. These findings confirm the existence of inverted U-shaped EKC. Furthermore, the results also confirm the existence of positive and significant impact of Energy Use (EU) on CO_2 emissions.

The present study has also applied a non-granger causality test and the result suggest unidirectional causality running from EG to CO_2 emissions. In literature, most of the studies applied the traditional Granger causality test but this study has applied a relatively new non-causal Granger test presented by Dumitrescu and Hurlin (2012) to check the causality between EG and CO_2 emissions. The results confirm that EG is significantly contributing towards CO_2 emissions. The results of the study reconfirm the EKC hypothesis for South Asia using improved estimation methodologies. Based on empirical findings; this study recommends that the policymakers of the six South Asian courtiers selected for this study should formulate such policies which encourage adopting environment-friendly technologies. The energy sources should be shifted from non-renewable to renewable energy sources to minimize the environmental hazard.

REFERENCES

Abbasi, M.A., Parveen, S., Khan, S., Kamal, M.A. (2020), Urbanization and energy consumption effects on carbon dioxide emissions: Evidence from Asian-8 countries using panel data analysis. Environmental Science and Pollution Research, 27(15), 18029-18043.

Acheampong, A.O. (2018), Economic growth, CO_2 emissions and energy consumption: What causes what and where? Energy Economics, 74(3), 677-692.

Ahmad, A., Zhao, Y., Shahbaz, M., Bano, S., Zhang, Z., Wang, S., Liu, Y. (2016), Carbon emissions, energy consumption and economic growth: An aggregate and disaggregate analysis of the Indian economy. Energy Policy, 96(3), 131-143.

Ahmed, K., Rehman, M.U., Ozturk, I. (2017), What drives carbon dioxide emissions in the long-run? Evidence from selected South Asian Countries. Renewable and Sustainable Energy Reviews, 70(3), 1142-1153.

Aljadani, A., Toumi, H., Toumi, S., Hsini, M., Jallali, B. (2021), Investigation of the N-shaped environmental Kuznets curve for COVID-19 mitigation in the KSA. Environmental Science and Pollution Research, 28(1), 29681-29700.

Allard, A., Takman, J., Uddin, G.S., Ahmed, A. (2018), The N-shaped environmental Kuznets curve: An empirical evaluation using a panel quantile regression approach. Environmental Science and Pollution Research, 25(6), 5848-5861.

Al-Mulali, U., Che Sab, C.N.B. (2018), Electricity consumption, CO_2 emission, and economic growth in the Middle East. Energy Sources, Part B: Economics, Planning, and Policy, 13(5), 257-263.

Andrews, D.W.K. (1991), Heteroskedasticity and autocorrelation consistent covariance matrix estimation. Econometrica, 59(3), 817-858.

Apergis, N., Ozturk, I. (2015), Testing environmental Kuznets Curve hypothesis in Asian countries. Ecological Indicators, 100(52), 16-22.

Ardakani, M.K., Seyedaliakbar, S.M. (2019), Impact of energy consumption and economic growth on CO2 emission using multivariate regression. Energy Strategy Reviews, 26(20), 1-13.

Arellano, M. (2003), Panel Data Econometrics. Oxford: Oxford University Press.

Asif, M., Sharma, R.B., Adow, A.H.E. (2015), An empirical investigation of the relationship between economic growth, urbanization, energy consumption, and CO_2 emission in GCC countries: A panel data analysis. Asian Social Science, 11(21), 270-285.

Aslanidis, N., Iranzo, S. (2009), Environment and development: Is there a Kuznets curve for CO_2 emissions? Applied Economics, 41(6), 803-810.

Aye, G.C., Edoja, P.E. (2017), Effect of economic growth on CO_2 emission in developing countries: Evidence from a dynamic panel threshold model. Cogent Economics and Finance, 5(1), 1379239.

Azimi, M., Feng, F., Zhou, C. (2020), Environmental policy innovation in China and examining its dynamic relations with air pollution and economic growth using SEM panel data. Environ Sci Pollut Res Int, 27(9), 9987-9998.

Baltagi, B. (2008), Econometric Analysis of Panel Data. United States: John Wiley & Sons.

Baum, C. (2011), XTTEST2: Stata Module to Perform Breusch-pagan LM Test for Cross-sectional Correlation in Fixed Effects Model. New Delhi: Staff Selection Commission.

Begum, R.A., Sohag, K., Abdullah, S.M.S., Jaafar, M. (2015), CO_2 emissions, energy consumption, economic and population growth in Malaysia. Renewable and Sustainable Energy Reviews, 41(3), 594-601.

Bekhet, H.A., Lojuntin, S.A. (2020), Does government expenditure contribute to Malaysia environmental sustainability? A dynamic analysis. Global Business and Management Research, 12(4), 61-72.

Bhagwati, J.N. (1988), Protectionism. Vol. 1. United States: MIT Press.

Bölük, G., Mert, M. (2015), The renewable energy, growth and environmental Kuznets curve in Turkey: An ARDL approach. Renewable and Sustainable Energy Reviews, 52(3), 587-595.

Chang, C.C. (2010), A multivariate causality test of carbon dioxide emissions, energy consumption and economic growth in China. Applied Energy, 87(11), 3533-3537.

Chen, P.Y., Chen, S.T., Hsu, C.S., Chen, C.C. (2016), Modeling the global relationships among economic growth, energy consumption and CO_2 emissions. Renewable and Sustainable Energy Reviews, 100(65), 420-431.

Chontanawat, J. (2020), Relationship between energy consumption, CO_2 emission and economic growth in ASEAN: Cointegration and causality model. Energy Reports, 6(1), 660-665.

Dinda, S. (2004), Environmental Kuznets curve hypothesis: A survey. Ecological Economics, 49(4), 431-455.

Drukker, D.M. (2003), Testing for serial correlation in linear panel-data models. The Stata Journal, 3(2), 168-177.

Dumitrescu, E.I., Hurlin, C. (2012), Testing for Granger non-causality in heterogeneous panels. Economic Modelling, 29(4), 1450-1460.

Erdoğan, S., Yıldırım, D.Ç., Gedikli, A. (2019), Investigation of causality analysis between economic growth and CO_2 emissions: The case of BRICS-T countries. International Journal of Energy Economics and Policy, 9(6), 430-438.

Erdoğan, S., Yıldırım, D.Ç., Gedikli, A. (2020), Relationship between oil revenues and education in gulf cooperation council countries. International Journal of Energy Economics and Policy, 10(1), 193-201.

Fodha, M., Zaghdoud, O. (2010), Economic growth and pollutant emissions in Tunisia: An empirical analysis of the environmental Kuznets curve. Energy Policy, 38(2), 1150-1156.

Franklin, R.S., Ruth, M. (2012), Growing up and cleaning up: The environmental Kuznets curve redux. Applied Geography, 32(1), 29-39.

Froot, K.A. (1989), Consistent covariance matrix estimation with cross-sectional dependence and heteroskedasticity in financial data. Journal of Financial and Quantitative Analysis, 24(3), 333-355.

Gorus, M.S., Aydin, M. (2019), The relationship between energy consumption, economic growth, and CO2 emission in MENA countries: Causality analysis in the frequency domain. Energy, 168(C), 815-822.

Greene, W.H. (2003), Econometric Analysis. Indai: Pearson Education India.

Grossman, G.M., Krueger, A.B. (1995), Economic growth and the environment. The Quarterly Journal of Economics, 110(2), 353-377.

Hausmann, J.A. (1978), Specification tests in econometrics. Econometrica, 46(6), 1251-1271.

Hoechle, D. (2007), Robust standard errors for panel regressions with cross-sectional dependence. The Stata Journal, 7(3), 281-312.

Holtz-Eakin, D., Selden, T.M. (1995), Stoking the fires? CO_2 emissions and economic growth. Journal of Public Economics, 57(1), 85-101.

Houghton, E. (1996), Climate Change 1995: The Science of Climate Change: Contribution of Working Group I to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Vol. 2. Cambridge: Cambridge University Press.

Hsiao, C. (2007), Panel data analysis-advantages and challenges. Test, 16(1), 1-22.

Im, K.S., Pesaran, M.H., Shin, Y. (2003), Testing for unit roots in heterogeneous panels. Journal of Econometrics, 115(1), 53-74.

Islam, R., Abdul Ghani, A.B., Mahyudin, E. (2017), Carbon dioxide emission, energy consumption, economic growth, population, poverty and forest area: Evidence from panel data analysis. International Journal of Energy Economics and Policy, 7(4), 99-106.

Ito, K. (2017), CO_2 emissions, renewable and non-renewable energy consumption, and economic growth: Evidence from panel data for developing countries. International Economics, 151(3), 1-6.

Jalil, A., Mahmud, S.F. (2009), Environment Kuznets curve for CO_2 emissions: A cointegration analysis for China. Energy Policy, 37(12), 5167-5172.

Jaunky, V.C. (2011), The CO_2 emissions-income nexus: Evidence from rich countries. Energy Policy, 39(3), 1228-1240.

Joo, Y.J., Kim, C.S., Yoo, S.H. (2015), Energy consumption, CO_2 emission, and economic growth: Evidence from Chile. International Journal of Green Energy, 12(5), 543-550.

Kao, C. (1999), Spurious regression and residual-based tests for cointegration in panel data. Journal of Econometrics, 90(1), 1-44.

Kasman, A., Duman, Y.S. (2015), CO_2 emissions, economic growth, energy consumption, trade and urbanization in new EU member and candidate countries: A panel data analysis. Economic modelling, 44(3), 97-103.

Khan, M.K., Khan, M.I., Rehan, M. (2020), The relationship between energy consumption, economic growth and carbon dioxide emissions in Pakistan. Financial Innovation, 6(1), 1-13.

Lee, S.R., Yoo, S.H. (2016), Energy consumption, CO_2 emissions, and economic growth in Korea: A causality analysis. Energy Sources, Part B: Economics, Planning, and Policy, 11(5), 412-417.

Levin, A., Lin, C.F., Chu, C.S.J. (2002), Unit root tests in panel data: Asymptotic and finite-sample properties. Journal of Econometrics, 108(1), 1-24.

Mehmood, U. (2021), Renewable-nonrenewable energy: Institutional quality and environment nexus in South Asian countries. Environmental Science and Pollution Research, 28(21), 26529-26536.

Mikayilov, J.I., Hasanov, F.J. (2020), Emissions-economic growth relationship revisited: New insights from the time-varying cointegration approach. Statistika, 100(2), 154-168.

Mohsin, M., Kamran, H., Nawaz, A., Hussain, S., Dahri, A. (2021), Assessing the impact of transition from nonrenewable to renewable energy consumption on economic growth-environmental nexus from developing Asian economies. J Environ Manage, 284(4), 111999-111999.

Mugableh, M.I. (2015), Economic growth, CO_2 emissions, and financial development in Jordan: Equilibrium and dynamic causality analysis. International Journal of Economics and Finance, 7(7), 98-105.

Munir, Q., Lean, H.H., Smyth, R. (2020), CO_2 emissions, energy consumption and economic growth in the ASEAN-5 countries: A cross-sectional dependence approach. Energy Economics, 85(1), 1-35.

Narayan, P.K., Narayan, S. (2010), Carbon dioxide emissions and economic growth: Panel data evidence from developing countries. Energy Policy, 38(1), 661-666.

Newey, W.K., West, K.D. (1987), A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. Econometrica, 55(3), 703-708.

Omri, A. (2013), CO_2 emissions, energy consumption and economic growth nexus in MENA countries: Evidence from simultaneous equations models. Energy Economics, 40(3), 657-664.

Özokcu, S., Özdemir, Ö. (2017), Economic growth, energy, and environmental Kuznets curve. Renewable and Sustainable Energy Reviews, 100(72), 639-647.

Pesaran, M.H. (2004), General Diagnostic Tests for Cross Section Dependence in Panels (IZA Discussion Paper No. 1240). Germany: Institute for the Study of Labor.

Pesaran, M.H. (2007), A simple panel unit root test in the presence of cross-section dependence. Journal of Applied Econometrics, 22(2), 265-312.

Pesaran, M.H. (2015a), Testing weak cross-sectional dependence in large panels. Econometric Reviews, 34(6), 1089-1117.

Pesaran, M.H. (2015b), Time Series and Panel Data Econometrics. Oxford: Oxford University Press.

Qasim, H.M., Majid, A., Jadoon, A.K. (2021), Institutional quality, trade openness and economic growth in South Asian Economies: Some new insights from a panel data analysis. South Asian Studies, 36(1), 17-38.

Rahman, H.U., Ghazali, A., Bhatti, G.A., Khan, S.U. (2020), Role of economic growth, financial development, trade, energy and FDI in environmental Kuznets curve for Lithuania: Evidence from ARDL bounds testing approach. Engineering Economics, 31(1), 39-49.

Raj, B., Baltagi, B.H. (2012), Panel Data Analysis. Germany: Springer Science and Business Media.

Riti, J.S., Song, D., Shu, Y., Kamah, M. (2017), Decoupling CO_2 emission and economic growth in China: Is there consistency in estimation results in analyzing environmental Kuznets curve? Journal of Cleaner Production, 166(1), 1448-1461.

Robalino-López, A., Mena-Nieto, Á., García-Ramos, J.E., Golpe, A.A. (2015), Studying the relationship between economic growth, CO_2 emissions, and the environmental Kuznets curve in Venezuela (1980-2025). Renewable and Sustainable Energy Reviews, 100(41), 602-614.

Salari, M., Javid, R.J., Noghanibehambari, H. (2021), The nexus between CO_2 emissions, energy consumption, and economic growth in the US. Economic Analysis and Policy, 69(3), 182-194.

Salazar-Núñez, H.F., Venegas-Martínez, F., Tinoco-Zermeño, M.Á. (2020), Impact of energy consumption and carbon dioxide emissions on economic growth: Cointegrated panel data in 79 countries grouped by income level. International Journal of Energy Economics and Policy, 10(2), 218-226.

Shaari, M.S., Hussain, N.E., Abdullah, H., Kamil, S. (2014), Relationship among foreign direct investment, economic growth and CO_2 emission: A panel data analysis. International Journal of Energy Economics and Policy, 4(4), 706-715.

Shabani, E., Hayati, B., Pishbahar, E., Ghorbani, M., Ghahremanzadeh, M. (2021), The relationship between CO_2 emission, economic growth, energy consumption, and urbanization in the ECO member countries. International Journal of Environmental Science and Technology, 18(7), 1-16.

Shahbaz, M., Khraief, N., Mahalik, M.K. (2020), Investigating the environmental Kuznets's curve for Sweden: Evidence from multivariate adaptive regression splines (MARS). Empirical Economics, 59(4), 1883-1902.

Sharma, G.D., Tiwari, A.K., Erkut, B., Mundi, H.S. (2021), Exploring the nexus between non-renewable and renewable energy consumptions and economic development: Evidence from panel estimations. Renewable and Sustainable Energy Reviews, 146(3), 111-152.

Studenmund, A.H. (2014). Using Econometrics a Practical Guide. United Kingdom: Pearson.

Wang, M.L., Wang, W., Du, S.Y., Li, C.F., He, Z. (2020), Causal relationships between carbon dioxide emissions and economic factors: Evidence from China. Sustainable Development, 28(1), 73-82.

Wooldridge, J.M. (2010), Econometric Analysis of Cross Section and Panel Data. United States: MIT Press.

Wooldridge, J.M. (2016), Introductory Econometrics: A Modern Approach. Canada: Nelson Education.

World Bank. (1992), World Development Report 1992: Development and the Environment. United States: The World Bank.

Wursten, J. (2017), XTCDF: Stata Module to Perform Pesaran's CD-test for Cross-sectional Dependence in Panel Context. Boston: Boston College Department of Economics.

Zaheer, R., Ali, S.R. (2021), Analysing the causal relationship among CO_2 emission, energy consumption and economics growth. PalArchs Journal of Archaeology of Egypt/Egyptology, 18(4), 3587-3595.